Ocean & Coastal Management 133 (2016) 95–104

Contents lists available at ScienceDirect

Ocean & Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

Assessment and management of western Mediterranean small-scale fisheries

Antoni Quetglas [a, *], Gorka Merino [b, c], Francesc Ordines [a], Beatriz Guijarro [a], Antoni Garau [d], Antoni M. Grau [e], Pere Oliver [a], Enric Massutí [a]

[a] Instituto Español de Oceanografía, Centre Oceanogràfic de les Balears, Moll de Ponent s/n, 07015 Palma de Mallorca, Spain
[b] AZTI-Tecnalia, Herrera Kaia, Portualdea, z/g, 20110 Pasaia Gipuzkoa, Spain
[c] Plymouth Marine Laboratory, Prospect Place, PL1 3DH, Plymouth, UK
[d] Federació Balear de Confraries de Pescadors, Camí de l'Escullera 4, 07012 Palma de Mallorca, Spain
[e] Direcció General de Pesca, Govern de les Illes Balears, Foners 10, 07006 Palma de Mallorca, Spain

ARTICLE INFO

Article history:
Received 15 April 2016
Received in revised form
7 September 2016
Accepted 23 September 2016

Keywords:
Small-scale fishery
Fishing tactics
Surplus production model
Bioeconomic model
Maximum sustainable yield (MSY)
Mediterranean

ABSTRACT

Nearly 75% of European fishing vessels belongs to small-scale fisheries (SSF). However, SSF have received little attention compared to industrial fisheries. In the Mediterranean Sea, where the SSF traditionally had a high socio-economic relevance, there is a widespread interest in securing its sustainable exploitation and viability. Here we analyze the SSF from Mallorca (Balearic Islands) using fishery statistics from the last 25 years (1990–2014). Although fleet size declined markedly (−55%), landings remained constant which might be related to different, not mutually exclusive explanations such as a decrease in unreported catches, stagnant and closed market or technological creeping. Multivariate analysis revealed eight different fishing tactics corresponding to the main target species. Aggregated, these eight species accounted for 52% and 71% of SSF landings weight and value, respectively. The fishery of these species is markedly seasonal and the landings of most of them showed important fluctuations but no clear trends. In contrast with the claims of SSF having lower impact on the natural resources than other fisheries, surplus production models revealed a generalized overexploitation of these target stocks, especially for the most high-valued species. Simulations with a bioeconomic model showed that fishing effort reductions of 38% would improve the health of fish stocks while increasing the economic profits to as much as 15% from current profits. If all stocks were kept below their MSY level, the reduction in fishing effort would have to be of 53% from current values. If the economic yield from the fishery was to be maximized (MEY), fishing effort would need to be reduced by 28%. Owing to important quantities of unreported catches in the most high-valued species, output values of the stock status indicators and the bioeconomic modelling should be taken with care beyond tracking trends in the fishery.

1. Introduction

Small-scale fisheries (SSF), e.g. those constituted of vessels of less than 12 m length (but see other definitions: Carvalho et al., 2011; Natale et al., 2015), are operated by the majority of fishers in the European Union (EU). Based on Data Collection Framework information, the SSF comprised 48,337 vessels, 74% of the total EU fleet in number, providing direct employment for c.a. 73,900 fishers, equating to 50% of the number of employees (STECF, 2015). Greece (23%), Italy (13%), Spain (11%), Portugal (11%) and France (9%) account for the largest share of the total European SSF (Macfadyen et al., 2011). In spite of these figures, SSF are underrepresented, or directly neglected, in fisheries assessment and management agendas at national and supranational levels for different reasons (e.g. Guyader et al., 2013). Firstly, it has been considered that it has comparatively low importance, both in terms of economic value and landings, in relation to large scale fisheries. Secondly, it has also traditionally been assumed that the use of static gears such as trammel nets and long lines have a relatively low impact on the exploited stocks compared to the most important fisheries (bottom trawlers and purse seiners). Thirdly, the high number of fishing units and its fragmentary distribution in

* Corresponding author.
E-mail address: toni.quetglas@ba.ieo.es (A. Quetglas).

http://dx.doi.org/10.1016/j.ocecoaman.2016.09.013
0964-5691/

multitude of ports and shelters along the coastline make the monitoring of the SSF extremely complex.

In the Mediterranean Sea, SSF have a high socio-economic relevance for the local communities as they represent an important share of the fish caught and constitute about 80% of the fisheries in terms of fishing units (Maynou et al., 2013). According to the First Regional Symposium on Sustainable Small-Scale Fisheries in the Mediterranean and the Black Sea (http://www.ssfsymposium.org/), there is a widespread interest in securing sustainable SSF in the area, where strong political commitment, intergovernmental cooperation and technical assistance for riparian states are needed. In this forum, it was also acknowledged that in order to provide a full picture of SSF in the Mediterranean, comprehensive information should be collected from riparian countries and analyzed in depth, as improving the knowledge on SSF will help in defining strategies to address the sector in terms of management, monitoring and sustainable development actions.

The SSF from Mallorca (Balearic Islands) has, as in most Mediterranean areas, a long tradition since there are written regulations dating from the 16th century (Iglesias et al., 1994). Although fishing has traditionally had a high socio-economic importance for the local economies, the current dependence of coastal Mediterranean areas on tourism has relegated it to a minor economic activity. Currently, total fishing production (all fisheries combined) in the Balearic Islands represents less than 0.08% of GDP (Pou, 2015). However, its importance nowadays lies in providing fresh, local seafood of high quality to both local consumers and tourists.

Up to now, two preliminary bioeconomic and socioeconomic analyses of the SSF from Mallorca have been performed. Merino et al. (2008) published a first assessment and bioeconomic analysis of the trammel net fishery. However, this analysis did not include two pivotal resources for the SSF, the spiny lobster and the dolphinfish, which are the most important species in terms of economic value and biomass, respectively. In addition, this work analyzed data from a period (2002–2006) previous to the global recession (2008) that had severe implications for the Spanish socioeconomy (Crescimanno et al., 2014). Maynou et al. (2013) analyzed the socioeconomic status of this SSF by means of economic indicators derived from data obtained through questionnaires. Although this work is an excellent first socioeconomic approach to the SSF, it constitutes a snapshot of the fisheries situation in 2009. None of these two works provided data on catch and effort for the entire SSF from Mallorca and its interannual dynamics or characterized the main fishing tactics.

In the present study we perform an in-depth analysis of the SSF from Mallorca using different data sources encompassing the last 25 years (1990–2014). We first analyze the main characteristics of this SSF determining the main fishing tactics (FTs) and corresponding target species using multivariate analysis. Secondly, we use surplus production models (SPM) to analyze the exploitation status of the target species defining those FTs. Thirdly, we perform a bioeconomic analysis of the SSF using MEFISTO, a bioeconomic model specifically designed for the simulation of Mediterranean fisheries (Lleonart et al., 2003). This work adds to a previous bioeconomic analysis of the bottom trawl fishery from Mallorca (Merino et al., 2015) and the outputs of both studies will help to design sustainable management scenarios for Mediterranean fisheries in the framework of the new Common Fisheries Policy, such as the commitment to bring all European fish stocks to a state where they can produce at MSY by 2020 at the latest (Regulation N° 1380/2013).

2. Material and methods

Annual catch per unit effort (CPUE) of the SSF from Mallorca (Balearic Islands) between 1990 and 2014 were estimated using fishery statistics (landings in kg; fishing effort in working days) provided by the local fish first-sale auction (OPMALLORCAMAR). These data are the official statistics from the study area and thus constitute the most reliable available information. Although daily sale bills from 2000 onwards were provided computerized, data from previous years are still on sheets and introducing all these data (catch per species, port and day) into databases will take years. For this reason, only data from the main target species obtained in the present analyses were computerized. Data on technical characteristics of this SSF were downloaded from Spanish Ministry datasets of national fishing fleets (www.magrama.gob.es).

2.1. Characterization

In order to identify the main fishing tactics (FTs) or métiers of the SSF, the daily sale bills of Mallorca were grouped using cluster analysis (Pelletier and Ferraris, 2000). A matrix of catch profiles (catch in kg by species, vessel and day) was created. Species (or commercial categories) appearing in less than 4% of the samples were omitted, as well as daily landings lower than 2 kg. Data were square-root transformed and the Bray–Curtis index was used as a similarity measure. The Unweighted Pair-Group Method with Arithmetic Mean was applied to link samples into clusters. The Similarity Percentage analysis (SIMPER) was used to assess the contribution of each species to the detected groups and assigning the main FT. These statistical analyses were carried out using R and the PRIMER 6 package (Clarke and Warwick, 1994). The main target species resulting from this cluster were then used in all posterior analysis.

2.2. Stock status

To determine the exploitation status of the SSF target species and to obtain input parameters for the bio-economic model, surplus production models were fitted to the catch-effort time series using the ASPIC software (Prager, 2004). The continuous-time Graham-Schaefer (logistic) model was implemented; this approach is an observation-error estimator assuming proportional error variance and conditioned on observed landings. For each estimated parameter, 80% bias-corrected confidence intervals were calculated by bootstrapping with 1000 iterations. In addition to the MSY, ASPIC estimates several benchmarks and stock status indicators such as population biomass (B), relative biomass (B/B_{MSY}), and relative fishing mortality (F/F_{MSY}); B_{MSY} and F_{MSY} stand for the B and F when stocks are exploited at their MSY. A general consensus is that $B/B_{MSY}<1$ and $F/F_{MSY}>1$ are indicative of an overexploitation state, while $B/B_{MSY}>1$ and $F/F_{MSY}<1$ are indicative of an underexploitation state (Prager, 2004). ASPIC requires starting guesses of the following estimated parameters: i) K, the stock's maximum biomass or carrying capacity; ii) MSY, the maximum sustainable yield; iii) B_1/K, the ratio of the biomass at the beginning of the first year to K; and iv) q, the catchability coefficient.

2.3. Bioeconomic modelling

Given that the SSF uses different FTs along the year, all target species have to be integrated when evaluating the economic performance of this fishery as a whole. Individual analyses for each stock will only give fragmentary information on the target stock and are thus not undertaken in this study. The bio-economic analysis was performed using an adapted R-version (R Core Team, 2013) of the MEFISTO 3.0 software (Mediterranean Fisheries Simulation Tools, www.mefisto.info). The model is structured in two main submodels, a biological and an economic model. Owing